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APPLICATION
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Title: BATTERY WITH COMPLETE DISCHARGE DEVICE

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Specification

BATTERY WITH COMPLETE DISCHARGE DEVICE

BACKGROUND OF THE INVENTION

Discarded partially discharged batteries can present a significant danger. Alkali metal batteries present a particular problem. Because the alkali metal such as lithium will burn when exposed to water, a partially discharged battery presents a significant concern.

In order to address this issue, many lithium batteries incorporate a circuit to completely discharge the battery. After the battery has discharged to the point where it is no longer useful, the complete discharge circuit is activated, totally consuming the lithium, thereby reducing or eliminating any fire hazard.

One such device is disclose in McCaleb U.S. Patent 5,119,009. This patent discloses a one-time switch used to close a complete discharge circuit. It requires that a pointed object push a switch element into the battery casing, closing the one-time switch. The battery then completely discharges and can be safely disposed.

Sink et al U.S. Patent 6,270,916 utilizes a different discharge circuit. Instead of a switch, it uses a spring clip which contacts a conductor, closing the circuit. In order to prevent discharge, an insulating strip is place between the clip and the conductor. When it is desired to discharge the battery, the strip is removed, the spring clip then makes contact with the conductor, and the battery discharges. This has the advantage of not requiring a separate device to close the switch. If the spring clip is not properly biased, the proper contact will not be made. Further, if the insulator strip is improperly positioned, it can cause a premature discharge of the battery. Moisture can also cause the circuit to close.

SUMMARY OF THE INVENTION

The present invention is premised on the realization that a complete discharge device (CDD) for a battery, in particular a lithium battery, can employ a spring biased switch. A spring biased switch has an element which, when in an extended position, is closed. The device also includes a block or other structure that has a bore or opening that aligns with this spring biased element. A tab inserted between the spring biased element of the switch and the opening in the block prevents the spring-biased element from extending outward and keeps the switch on the complete discharge device in an open position. When the tab is pulled, the spring in the switch forces the element outward, thereby

closing the switch and activating the complete discharge device. Preferably, the element is simply a post.

The invention will be further appreciated in light of the following detailed description and drawings in which:

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a perspective view of a battery incorporating the present invention.

FIG. 2 is a perspective view partially broken away showing the switch mechanism according to the present invention in the closed position.

FIG. 3 is an alternate embodiment of the device shown in FIG. 2 with the switch in the open position.

FIG. 4 is a circuit diagram showing a complete discharge circuit.

DETAILED DESCRIPTION OF THE DRAWINGS

As shown in Figures 1 and 2, the complete discharge circuit **10** of the present invention is encased within a battery **11** and designed to connect a load across the cell strings of a battery, thereby discharging it completely. The battery **11** includes a top wall **13** having positive and negative terminals **16** and **17**. The complete discharge switch **12** is located on the inside surface **19** of front wall **13** of the battery. The switch **12** can be located on the inside surface of any exterior wall of battery **11** or on a printed circuit board mounted within

a battery and located where a tab **24** can be extended through an exterior wall.

Switch **12** of circuit **10** includes a plunger element **14** spring biased in the direction of arrow **16**. Element **14** is shown partially in phantom in the Figures. This element **14** is aligned with an opening **18** between two blocks or obstructions within the battery **11**. The opening can be established by a structure **21** having blocks **21a** and **21b** as shown in FIG. 2, or, as shown in FIG. 3, can actually be two electrical components **20,22** such as capacitors, resistors, or the like, which form part of the circuitry on the inside surface of wall **13**. This surface **19** as shown is a circuit board which incorporates the CDD circuit.

As shown in FIG. 3, the switch is held in an open position by a pull tab **24** of a thermally stable yet flexible material such as polyester. This extends from the exterior of the battery through a slot **27** in the battery and slot **26** in surface **13** of circuit board **19** between blocks **21a,21b** and switch **12**. Thus, tab **24** blocks the opening **18** and prevents the element **14** from moving in the direction of arrow **16**.

On the exterior of battery **11**, the tab **24** is held in place by a piece of pressure sensitive tape **25** to avoid inadvertent pulling and thus discharge of the battery **11**. Other protective measures can also be employed such as a plastic cap or application of pressure sensitive adhesive to the exterior surface of tab **24** to adhere this portion to the exterior surface of battery **11**.

To activate the complete discharge circuit, tape **25** is removed and tab **24** is pulled. As shown in Figure 2, element **14** then moves into opening **18**, thereby closing the switch and closing the circuit **10** causing the device to discharge completely. The discharge is controlled by circuit **10** to allow a controlled discharge of the battery so that excess heat is not generated and fire danger is reduced. A constant resistance circuit is shown. A constant current discharge can also be employed, if desired.

This system eliminates the problems associated with using simply an insulator between two conductors and yet provides a simple, easy method for activating a complete discharge circuit.

Having described this invention, its advantages and parameters, it will be obvious to a person of ordinary skill in the art, in view of the above description, that variations thereof may be made without departing from the spirit and scope thereof.

WHAT IS CLAIMED IS: